

Supplement Materials for Global Value Chain Integration and Individual Labor Market Outcomes: An Investigation Using Taiwan's Panel Study of Family Dynamics

Chi-Yuan Tsai

1. Data

1.1 Panel Study of Family Dynamics

Taiwan's Panel Study of Family Dynamics (PSFD) is a survey conducted by Academia Sinica and is available to researchers upon registration (Chu 1999-2004; Kan 2005-2012; Chang 2014; Yu 2016, 2018, 2020).¹ The data includes two types of samples: the main samples and the children samples. The main samples were initially drawn using a multi-stage stratified sampling method, utilizing government household records to ensure representativeness in five waves: 1999 (born 1953-1964), 2000 (born 1935-1954), 2003 (born 1964-1976), 2009 (born 1977-1983), and 2016 (born 1984-1991). Follow-up surveys were conducted annually, and since 2012, they have been conducted biannually. The children samples consist of the children of the interviewees born after 1977, who are added to the dataset once they reach 16 years of age. In this study, I rely solely on the main sample data. Each survey provides a 7-digit code to identify respondents, which is used to merge datasets across years.

To construct the main dependent variable in this study, sector switch, and the controlled variable, skill levels of occupations, two survey questions are used.² The first

¹ The data and related English documentation can be accessed through the following webpage: https://psfd.sinica.edu.tw/V2/?page_id=446&lang=en.

² It should be noted in advanced that the questionnaires across surveys are not perfectly unified, leading to differences in question codes and the ways that questions are phrased.

question is, “Did you have a job this year (January)?” and the second question is, “What is your current job (industry and occupation)?” Before 2008, respondents answered either “Yes” or “No” to the first question. Since 2008, an additional option, “Yes, I work for a family business more than 15 hours a week or 3 hours daily without salary,” was included. For consistency, I treat both “Yes” and this new option as indicating employment. If respondents answered "Yes" to the first question, they were required to provide information about their industry and occupation for that year. Between 2006 and 2012, an additional question was asked in the surveys: “Has your job changed since January 2005 (the previous year)?” If respondents answered "No," they skipped the questions about industry and occupation. As a result, if a respondent reports no job change at time $t+2$ but is missing from the interview at $t+1$, their occupations and industries are not recognized and hence are treated as missing values. Using these questions, I construct the sector switch dummy, which takes the value of one if a respondent switches sectors within a two-year window, in the following situations: (1) the respondent provides information about their industry both at time t and $t+2$, and the industries differ, or (2) the respondent reports different industries at time t and $t+1$ but answers "No job change" at time $t+2$.

The industries in the surveys were recorded using Taiwan’s fourth edition of the 2-digit industry classification system, which was primarily based on the International Standard Industrial Classification, version 2 (ISIC v.2), until 2009. After 2009, the codes followed Taiwan’s eighth edition classification, which is compatible with ISIC v.3. Similarly, occupations before 2009 were recorded using Taiwan’s fifth edition of the occupation classification system, based on the International Standard Classification of Occupations (ISCO-88) from International Labour Organization (ILO). After 2009, Taiwan

adopted the fifth edition, compatible with ISCO-08. The occupations are further categorized into 4 skill levels by ILO. This study defines the occupations in skill level 3 and 4 as the skilled occupations. These are managers, professionals, and Technicians and associate professionals in ISCO-08 and legislators, senior officials and managers, professionals, and technicians and associate professionals in ISCO-88.³ Table 1 provides the codes and survey questions used to construct the variables for the study across each survey. The information on the quality of the matching process over two-year intervals is reported in Table 2.

Table 2 shows attrition and matching rates across the surveys. The attrition rates are defined as the number of observations at time $t+2$ divided by the number of observations at time t . The matching rates are defined as the number of observations that exist and have identified sectors at both time t and $t+2$, divided by the number of observations at time t . It can be observed that, except for Wave 2 during the 2018–2020 interval and Wave 5 during the 2016–2018 and 2018–2020 periods, the attrition rates remain consistently below 10 percent. Compared to other waves, the respondents in Wave 2 are the oldest, with the youngest being around 64 and the oldest around 83 years old in 2018, meaning that most of them were at or beyond the legal retirement age. This suggests that the higher attrition may largely reflect natural attrition due to aging or retirement. As for Wave 5, the higher attrition rates may result from the fact that these respondents were newly added to the surveys, and rejection rates for follow-up surveys are typically higher during the early stages. The matching ratios range from 75 percent to 97 percent, with lower values

³ The English version of Taiwan's classification is available at: <https://statdb.mol.gov.tw/html/svy12/1236menu.htm>.

occurring during the 2006–2012 period. As previously discussed, this is because, by design, respondents who did not change jobs were directed to skip the industry question. As a result, if their information is missing at time $t+1$ and they report no job changes at $t+2$, their sectors cannot be identified and are classified as non-matched. Overall, the matched samples contain 25,104 observations. This study focuses on the individuals up to four years younger than the legal retirement age—which was 60 before 2008 and 65 thereafter and excludes those serving in government positions or the military. Specifically, For the 2004–2006 window, the sample includes individuals aged under 57; for 2006–2008, those under 59; and after 2008, those under 62 at the start of each window period. This subsample includes 16,260 observations.

1.2 Other Data

Two additional data sources are used to construct Taiwan’s regional sectoral labor shares and the supply of high-skilled labor. The first is the Yearbook of Manpower Survey Statistics from 1999 to 2003. The relevant tables include Civilian Population Aged 15 Years and Over by Educational Attainment and Age and Employed Persons by Industry. These tables provide city- and county-level data on the adult population by education level, as well as the number of employed persons across major service industries and the manufacturing sector as a whole. These data are used to construct the change in the number of adults with a bachelor’s degree or higher, denoted as Δ Hunan Cap in the paper. Further, to obtain more detailed industry-level data within manufacturing, the Factory Operation Census Report is used. This report offers county- and city-level information on the number of factory employees by two-digit ISIC Rev. 4 industry codes for the manufacturing sector.

Hence, the amounts of employees of 2-digit industry m at city (county) c in year t are approximated by:

$$\hat{L}_{cmt} = L_{cst}^{Manpower} \frac{L_{cmt}^{Factory}}{L_{cst}^{Factory}}, \quad (1)$$

where s refers to the sector defined in the Yearbook of Manpower Survey Statistics.⁴

Using equation (1), the study aggregates the estimated number of employees to the sector and regional levels as defined in the appendix of the main paper. The labor shares used to construct the trade exposure measures for region d , sector j in equation (4) of the main paper are calculated as:

$$\frac{L_{j0}^d}{L_{j0}} = \frac{1}{5} \sum_{t=1999}^{2003} \sum_{m \in j} \sum_{c \in d} \frac{\hat{L}_{cmt}}{L_{jt}}. \quad (2)$$

⁴ Yearbook of Manpower Survey after year 2013 can be reached at <https://eng.stat.gov.tw/>; Factory Operation Census can be reached at https://www.moea.gov.tw/Mns/dos_e/home/Home.aspx.

Table 1 Questions and Variables

Datafile names: RIIRVRVI2004, RR2005-20			
Code	Definition	Variables	Notes
a03(2004); a11a(2005); a07(2006); a05(2007-12, 14); a06a01(2016); a06a(2018).	Did you have a job?	nnchsec nnnchsec entry entryhgv	2-digit code of industries; 4-digit code of occupations.
a05a01, a05a02(2004); a13a01, a13a02(2005); a11a01, a11a02(2006); a09a01, a09a02(2007-12); a07a01, a07a02(2014); a08a01, a08a02 (2016, 18).	What is your current job?	stskill stsec	
a06a02(2004); a14a02(2005); a12a01(2006); a09f02(2009); a09b02(2007-8, 10-12); a07c02(2014); a08c02(2016, 18).	Where is your workplace ?	stregion	3-digit zip code
x06(2004-5); z04b(2006); x05(2007-12, 14, 16, 18).	Presently address	stregion	3-digit zip code
a05c(2004); a13c(2005); a11c(2006); a08c(2007-12); a07b(2014); a08b(2016, 18).	How many employees are there in that company?	Largefirm	
a05b(2004); a13b(2005); a11b(2006); a08b(2007-12); a06(2014); a07(2016); a07a(2018).	For whom did you work?	Stateowned	
a08b(2004); a16b(2005); a13a06(2006). a10b(2007-8); a10a(2009-12); a08a(2014); a09a01(2016, 18)	What is the average monthly income of your current job?	incinc incdec	

Table 1 Questions and Variables (Continued)

Data filenames: RI1999, RI2000, RI2003, RI2009			
Code	Definition	Variables	Notes
b01(1999, 2000, 3, 9, 16)	Education level	HEdu	
a01(1999, 2000, 3, 9, 16)	Gender	gender	
a02(1999, 2000, 3); a02z01(2009); a02a01(2016)	Birth year	stage, aged	
weight_adj_3 (1999, 2000, 3, 9, 16)	Weights	weight_adj_3	

Source: The author's calculation based on described data sets.

Table 2 Number of Samples

	Year	04	06	08	10	12	14	16	18	20
W1	All samples	705	664	615	564	545	518	488	469	429
	Attrition		94%	92%	92%	97%	95%	94%	96%	91%
	Year	04-06	06-08	08-10	10-12	12-14	14-16	19-18	18-20	
	Matched	539	560	491	449	449	475	451	414	
	Matching ratio	76%	84%	80%	80%	82%	92%	92%	88%	
W2	All samples	1489	1340	1258	1158	1065	977	910	806	696
	Attrition		90%	94%	92%	92%	92%	94%	89%	87%
	Year	04-06	06-08	08-10	10-12	12-14	14-16	19-18	18-20	
	Matched	1211	1084	951	867	831	897	801	689	
	Matching ratio	81%	81%	76%	75%	78%	92%	88%	85%	
W3	All samples	830	768	715	685	652	602	562	533	484
	Attrition		93%	93%	96%	95%	92%	93%	95%	91%
	Year	04-06	06-08	08-10	10-12	12-14	14-16	19-18	18-20	
	Matched	640	617	558	516	504	547	515	472	
	Matching ratio	77%	80%	78%	75%	77%	91%	92%	89%	
W4	All samples	X	X	X	1721	1644	1539	1497	1421	1302
	Attrition					96%	94%	97%	95%	92%
	Year	04-06	06-08	08-10	10-12	12-14	14-16	19-18	18-20	
	Matched	X	X	X	1406	1354	1432	1356	1240	
	Matching ratio				82%	82%	93%	91%	87%	
W5	All Samples	X	X	X	X	X	X	1972	1588	1388
	Attrition								81%	87%
	Year	04-06	06-08	08-10	10-12	12-14	14-16	16-18	18-20	
	Matched	X	X	X	X	X	X	1525	1263	
	Matching ratio							77%	80%	
W1~W5	All samples	36403								
	Matched	25104								
	Subsamples	16260								

Source: The author's calculation based on described data sets.

2. Continued Tables

Table 3 to Table 5 report the continuation of Table 2 to Table 4 in the main paper. Table 6 and 7 reports the results for job separation and entry without considering the survey design and the sampling weights, used as a robustness check for the results of Table 4. Table 8 is associated with Table 3 in the main paper by including the export measures other than VSE into the regressions. Table 9 and Table 10 report the continuation of Table 5 and Table 6 in the main paper.

	(1)	(2)	(3)	(4)
		Sector Switch		
		Backward selection	No adjustment for survey design	
			No weights	
Skill	-0.0317*** (0.0102)	-0.0322*** (0.0102)	-0.0320*** (0.00967)	-0.0321*** (0.00892)
HEdu	-0.0147 (0.0136)	-0.0147 (0.0136)	-0.0147 (0.0100)	-0.0140 (0.00945)
Female	0.0160 (0.0101)	0.0167* (0.00984)	0.0166* (0.00852)	0.0151* (0.00819)
Large firm	-0.0740*** (0.0124)	-0.0738*** (0.0125)	-0.0739*** (0.0112)	-0.0794*** (0.0107)
State-owned	-0.0511* (0.0295)	-0.0522* (0.0279)	-0.0519** (0.0232)	-0.0573** (0.0225)
Δ Human Cap	0.0274** (0.0135)	0.0271** (0.0135)	0.0270** (0.0129)	0.0291** (0.0118)

Notes: (1) Standard errors adjusted by survey design in parentheses in (1) and (2);
(2) Clustered standard errors at time-strata level in parentheses in (3) and (4);
(3) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.
(4) This table is a continuation of Table 2 in the main paper.

Source: The author's calculation based on described data sets.

Table 4 Exports and Labor Market Outcomes-2SLS (Continued)

	(1)	(2)	(3)	(4)	(5)
	Sector Switch			No adjustment for survey design	
				Backward selection	No weights
Skill	-0.0281*** (0.00998)	-0.0261** (0.0102)	-0.0297*** (0.0105)	-0.0308*** (0.00965)	-0.0300*** (0.00900)
HEdu	-0.0182 (0.0137)	-0.0194 (0.0137)	-0.0204 (0.0137)	-0.0206** (0.00975)	-0.0192** (0.00930)
Female	0.0149 (0.00990)	0.0146 (0.00995)	0.0157 (0.0100)	0.0170** (0.00857)	0.0144* (0.00828)
Large firm	-0.0733*** (0.0124)	-0.0729*** (0.0124)	-0.0732*** (0.0126)	-0.0722*** (0.0112)	-0.0774*** (0.0108)
State-owned	-0.0545* (0.0280)	-0.0536* (0.0282)	-0.0514* (0.0279)	-0.0524** (0.0238)	-0.0556** (0.0231)
ΔHuman Cap	0.0272** (0.0133)	0.0270** (0.0135)	0.0350** (0.0149)	0.0345** (0.0144)	0.0444*** (0.0144)

Notes: (1) Standard errors adjusted by survey design in parentheses in (1) to (3);
(2) Clustered standard errors at time-strata level in parentheses in (4) and (5);
(3) This table is a continuation of Table 3 in the main paper;
(4) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: The author's calculation based on described data sets.

Table 5 Job Separation and Entry-2SLS (Continued)

	(1)	(2)	(3)	(4)
	Separation	Entry	Entry	EntryHGV
Skill	-0.0207*** (0.00518)			
HEdu	-0.0183*** (0.00670)	0.0593** (0.0237)	0.0591** (0.0238)	0.0855*** (0.0216)
Female	0.0469*** (0.00518)	-0.117*** (0.0212)	-0.115*** (0.0211)	-0.0597*** (0.0166)
Large firm	-0.0121* (0.00692)			
State-owned	-0.0476*** (0.0112)			
ΔHuman Cap	0.0110 (0.00795)	0.0107 (0.0268)	0.0595** (0.0301)	0.0425 (0.0270)

Notes: (1) Standard errors adjusted by survey design in parentheses;
(2) This table is a continuation of Table 4 in the main paper;
(3) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sources: The author's calculation based on described data sets.

Table 6 Job Separation and Entry-2SLS

	(1) Separation	(2) Entry	(3) EntryHGV
VSE	0.0204** (0.00898)	-0.0550*** (0.0164)	-0.0349** (0.0140)
T.E.-final	-0.0335*** (0.00960)	0.0219 (0.0200)	0.0190 (0.0179)
Imports -Pure-forward		0.0600*** (0.0224)	0.0506** (0.0200)
VSE*Skill	-0.000715 (0.00110)		
VSE*Age40	0.00127 (0.00149)		
VSE* Labor intensity	-0.00354** (0.00179)		
VSE* Dposition	-0.00112 (0.00178)		
T.T.-final* Dposition	0.0139 (0.00927)		
Skill	-0.0198*** (0.00485)		
HEdu	-0.0186*** (0.00598)	0.0664*** (0.0215)	0.0853*** (0.0200)
Female	0.0470*** (0.00528)	-0.112*** (0.0162)	-0.0556*** (0.0151)
Large firm	-0.0123** (0.00596)		
State-owned	-0.0471*** (0.0113)		
Δ Human Cap	0.0104 (0.00849)	0.0530* (0.0287)	0.0346 (0.0278)

Table 6 Job Separation and Entry-2SLS (Continued)

	(1) Separation	(2) Entry	(3) EntryHGV
Fixed effects	V	Δ	Δ
P-value			
K-P LM	0.006	0.000	0.000
Hansen J	0.358	0.151	0.209
N	12789	3361	3361

Notes: (1) Clustered standard errors at time-strata level in parentheses;
(2) V: The fixed effects are described in the main text;
(3) Δ : The sector fixed effects are also excluded;
(4) The table is associate with Table 4 in the main paper;
(5) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sources: The author's calculation based on described data sets.

Table 7 Job Separation and Entry-2SLS No Weights

	(1) Separation	(2) Entry	(3) EntryHGV
VSE	0.0242** (0.00959)	-0.0479*** (0.0147)	-0.0269** (0.0129)
T.E.-final	-0.0332*** (0.00920)	0.0178 (0.0189)	0.0128 (0.0170)
Imports -Pure-forward		0.0504** (0.0204)	0.0420** (0.0189)
VSE*Skill	-0.000509 (0.00103)		
VSE*Age40	0.00136 (0.00140)		
VSE* Labor intensity	-0.00438** (0.00175)		
VSE* Dposition	-0.00149 (0.00168)		
T.T.-final* Dposition	0.0172* (0.00934)		
Skill	-0.0185*** (0.00453)		
HEdu	-0.0189*** (0.00583)	0.0583*** (0.0208)	0.0839*** (0.0197)
Female	0.0450*** (0.00500)	-0.108*** (0.0160)	-0.0519*** (0.0151)

Table 7 Job Separation and Entry-2SLS No Weights (Continued)

	(1)	(2)	(3)
	Separation	Entry	EntryHGV
Large firm	-0.0106** (0.00540)		
State-owned	-0.0442*** (0.0101)		
Δ Human Cap	0.0141* (0.00851)	0.0497* (0.0275)	0.0322 (0.0260)
Fixed effects	V	Δ	Δ
P-value			
K-P LM	0.007	0.000	0.000
Hansen J	0.152	0.317	0.360
<i>N</i>	12789	3361	3361

Notes: (1) Clustered standard errors at time-strata level in parentheses;

(2) V: The fixed effects are described in the main text;

(3) Δ : The sector fixed effects are also excluded;

(4) The table is associate with Table 4 in the main paper;

(5) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sources: The author's calculation based on described data sets.

Table 8 Exports and Labor Market Outcomes-2SLS

	(1)	(2)	(3)	(4)
T.E.	-0.0347 (0.0294)			
T.E.- Intermediate		-0.00922 (0.0336)		
Exports -Pure-forward			0.199 (0.201)	0.357 (0.381)
VSE	0.0134 (0.00954)	0.0153 (0.0176)	0.00455 (0.0115)	
Skill	-0.0243** (0.0106)	-0.0279*** (0.00993)	-0.0333*** (0.0115)	-0.0372** (0.0156)
HEdu	-0.0172 (0.0138)	-0.0175 (0.0140)	-0.0217 (0.0139)	-0.0256 (0.0174)
Female	0.0144 (0.00996)	0.0149 (0.00990)	0.0160 (0.0103)	0.0166 (0.0107)
Large firm	-0.0742*** (0.0123)	-0.0737*** (0.0125)	-0.0688*** (0.0141)	-0.0647*** (0.0169)
State-owned	-0.0525* (0.0279)	-0.0544* (0.0280)	-0.0570* (0.0297)	-0.0592* (0.0309)
Δ Hunan Cap	0.0101 (0.0176)	0.0228 (0.0220)	0.0616 (0.0423)	0.0943 (0.0853)
Fixed Effects	V	V	V	V
<i>N</i>	23329	23329	23329	23329

Notes: (1) Standard errors adjusted by survey design in parentheses;
(2) Fixed effects are described in the main text;
(3) The table is associate with Table 3 in the main paper;
(4) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Sources: The author's calculation based on described data sets.

Table 9 Trade Mode and Incomes (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
	Income Increase	Income Decrease	Income Increase	Income Decrease	Income Increase	Income Decrease
Skill	-0.00138 (0.0107)	0.0107 (0.0103)	-0.00101 (0.0108)	0.00992 (0.0102)	-0.000394 (0.0109)	0.0111 (0.0104)
HEdu	0.0511*** (0.0125)	-0.0412*** (0.0122)	0.0507*** (0.0125)	-0.0407*** (0.0123)	0.0500*** (0.0125)	-0.0420*** (0.0122)
Female	0.0103 (0.0110)	-0.0113 (0.0102)	0.0103 (0.0110)	-0.0112 (0.0102)	0.0101 (0.0110)	-0.0131 (0.00999)
Large firm	-0.233** (0.0993)	0.231** (0.0979)	-0.232** (0.0991)	0.231** (0.0984)	-0.243** (0.100)	0.229** (0.0987)
State-owned	0.00319 (0.0107)	0.00242 (0.0105)	0.00332 (0.0107)	0.00236 (0.0105)	0.00333 (0.0109)	0.00568 (0.0106)
Δ Hunan Cap	0.0986*** (0.0278)	-0.0947*** (0.0315)	0.0985*** (0.0277)	-0.0945*** (0.0314)	0.0970*** (0.0284)	-0.0900*** (0.0316)

Notes: (1) Standard errors adjusted by survey design in parentheses;
(2) This table is a continuation of Table 5 in the main paper;
(3) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: The author's calculation based on described data set

Table 10 Labor Market Outcomes and Individual Fixed Effects (Continued)

	(1)	(2)	(3)	(4)	(5)	(6)
	Sector Switch	Separation	Entry	EntryHGV	Income Increase	Income Decrease
Skill	0.00198 (0.0164)	-0.0108 (0.00809)			-0.0500** (0.0222)	0.0646*** (0.0211)
Large Firm	-0.0161 (0.0201)	-0.00748 (0.0107)			-0.0450* (0.0253)	0.0639*** (0.0236)
State-owned	-0.0393 (0.0657)	0.0127 (0.0299)			0.117 (0.0929)	-0.0564 (0.0727)
Δ Hunan Cap	0.0241* (0.0144)	0.00383 (0.00771)	0.0572 (0.0422)	0.0444 (0.0391)	-0.00443 (0.0227)	0.0252 (0.0207)

Notes: (1) Robust standard errors in parentheses;
(2) Fixed effects are described in the main text;
(3) Δ : The sector fixed effects are excluded;
(4) This table is a continuation of Table 6 in the main paper;
(5) * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$.

Source: The author's calculation based on described data sets.

Reference

Chang, Y. H. 2014. Panel Study of Family Dynamics [Data File]. Available from Survey Research Data Archive, Center for Survey Research, Research Center for Humanities and Social Sciences, Academia Sinica, Taipei, Taiwan. https://psfd.sinica.edu.tw/V2/?page_id=966&lang=en (accessed March 3, 025).

Chu, C. Y. C. 1999-2004. Panel Study of Family Dynamics [data file]. Available from Survey Research Data Archive, Academia Sinica, Taipei, Taiwan. https://psfd.sinica.edu.tw/V2/?page_id=966&lang=en (accessed March 3, 025).

Directorate-General of Budget, Accounting and Statistics 1999-2003. "Yearbook of Manpower Survey Statistics." Tapei, Taiwan: Executive Yuan.

Ministry of Economic Affairs 1999-2003. "Factory Operation Census Report." Taipei, Taiwan: Executive Yuan.

Kan, K. H. 2005-2012. Panel Study of Family Dynamics [Data File]. Available from Survey Research Data Archive, Academia Sinica, Taipei, Taiwan. https://psfd.sinica.edu.tw/V2/?page_id=966&lang=en (accessed March 3, 025).

Yu, R. R. 2016, 2018, 2020. Panel Study of Family Dynamics [Data File]. Available from Survey Research Data Archive, Academia Sinica, Taipei, Taiwan. https://psfd.sinica.edu.tw/V2/?page_id=966&lang=en (accessed March 3, 025).